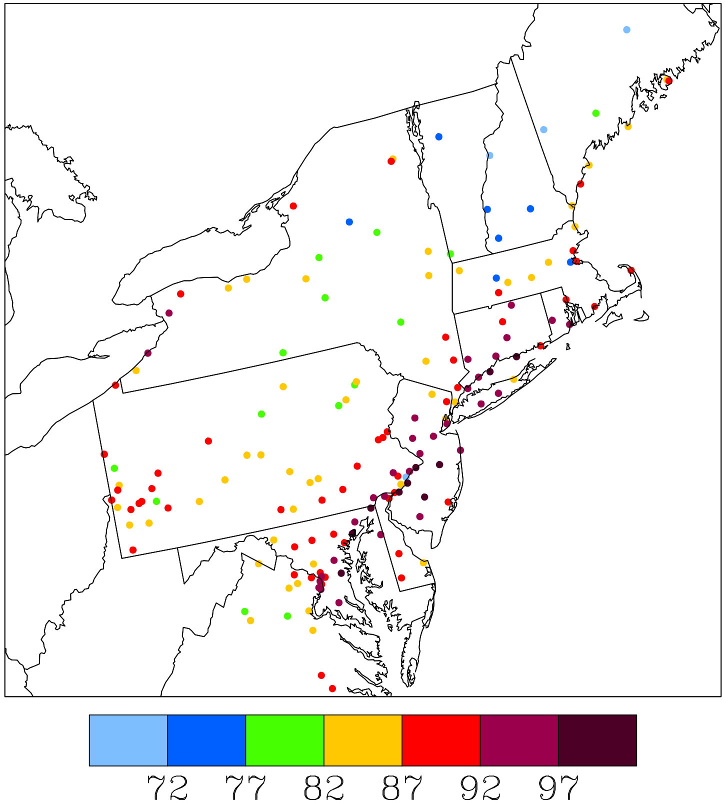
SIPRAC Briefing on Modeling for O3, PM2.5 and RHz SIPs



Dave Wackter, CTDEP, June 8, 2006

Overview

- SIP Schedules
- Air Quality
- Air Pollutant Emissions
- Base and Future Year Modeling
- Attainment Strategy

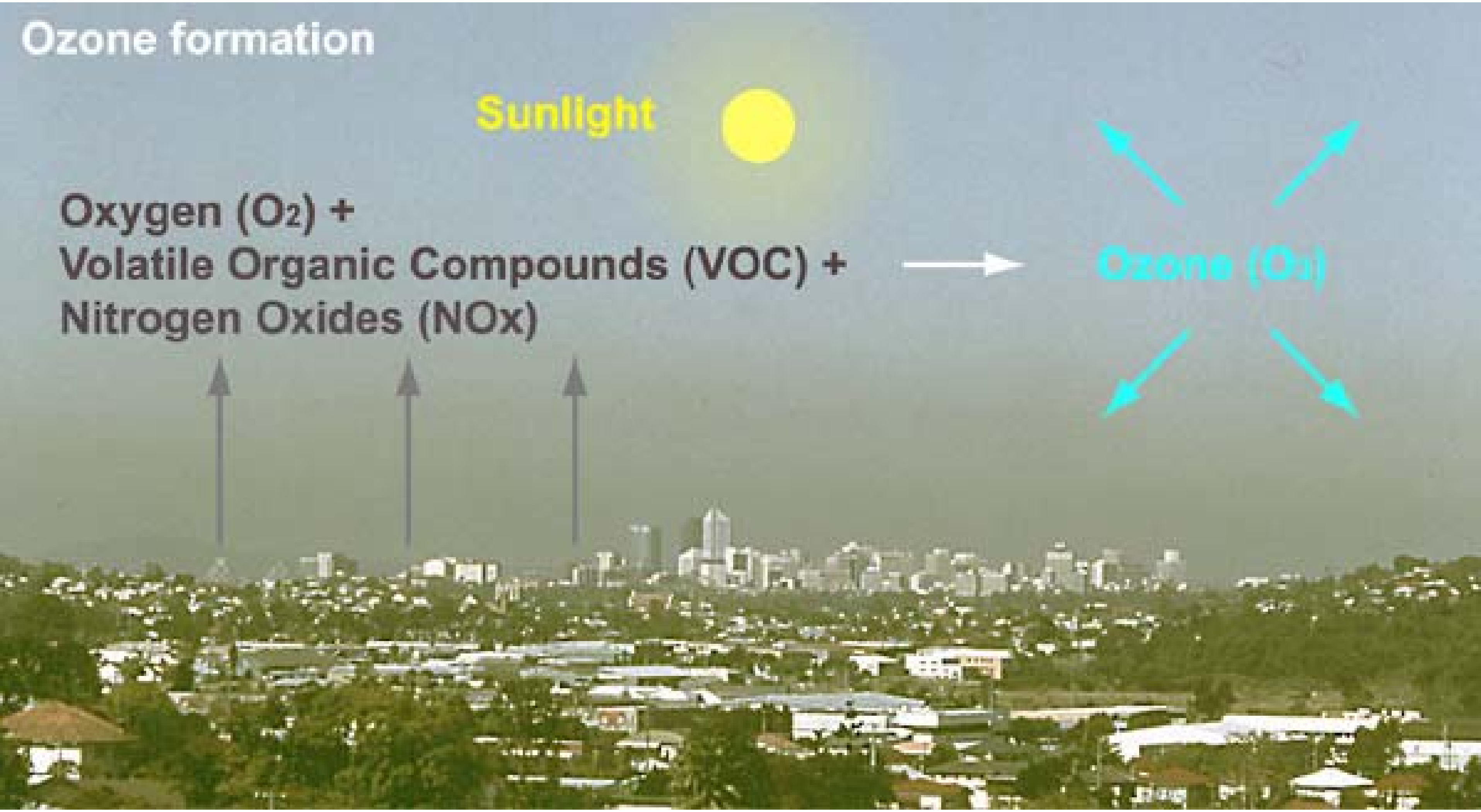
Recent EPA Actions

- CAIR (12May05)
- CAIR SIP/FIP (28Apr06)
- 8-hr O3 Phase 2 Rule (29Nov05)
- PM2.5 implementation proposal (01Nov05)
- PM2.5 and PM10-2.5 NAAQS proposal (signed 20Dec05)
- Regional Haze BART rule (06Jul05)

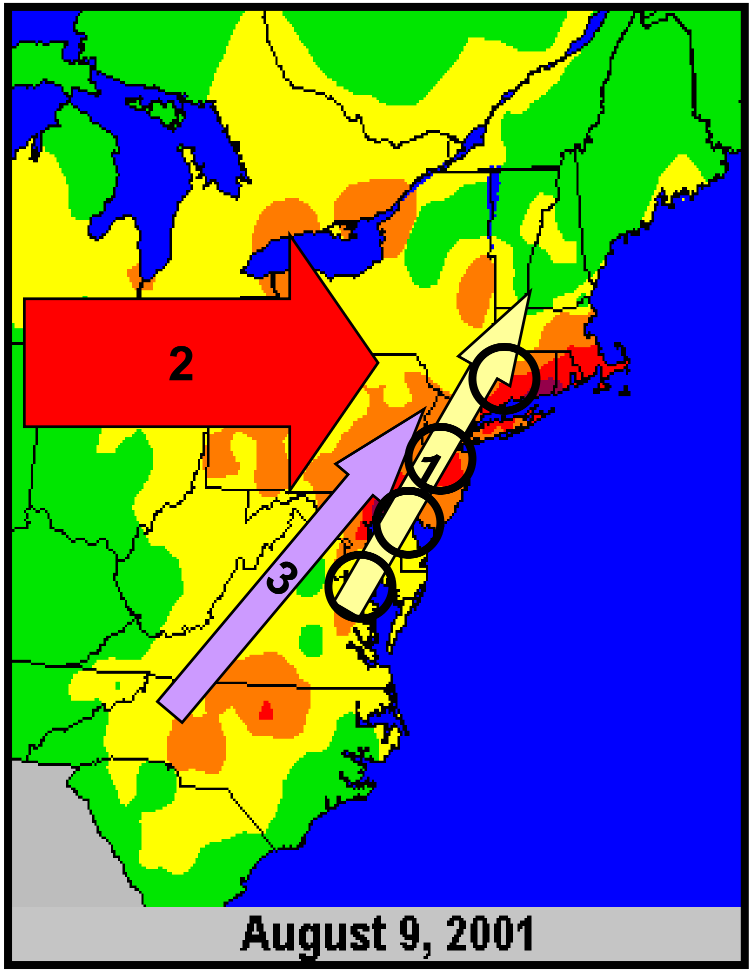
Timeframes for SIP Revisions

Due Date	SIP Revision
Jan 06	2002 emission inventory
Sept 06	RACT
Sept 06/Mar07	CAIR SIP full/abbreviated
June 07	8-hr O3 attainment plan
Dec 07	Regional Haze and BART
Apr 08	PM2.5 attainment plan

Simplified Photochemistry of O3 Formation



Where Does Our Air Pollution Come From?



Four Distinct Parts

- Local emissions in Nonattainment Areas (NAAs)
- Three types of transport

1 Short range
- "Ground level" transport
- VA to MD to PA to NJ to NY to CT to MA.

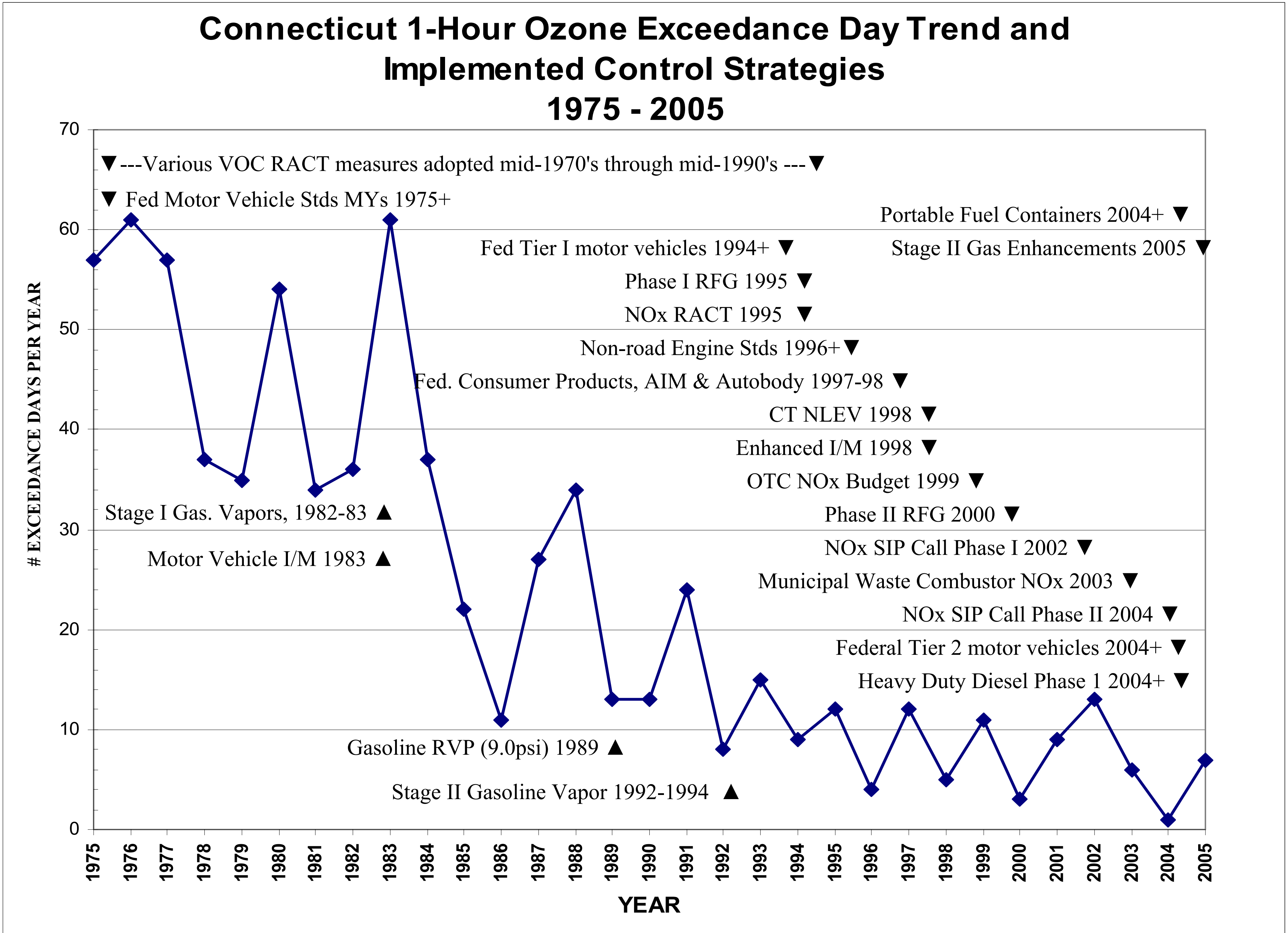
2 Long range (synoptic scale)
- "Aloft" transport
- 100s of miles
- Generally from W or NW

3 Low Level Night-Time Jets
- "Aloft" transport at night
- 100s of miles
- SW to NE along the Atlantic

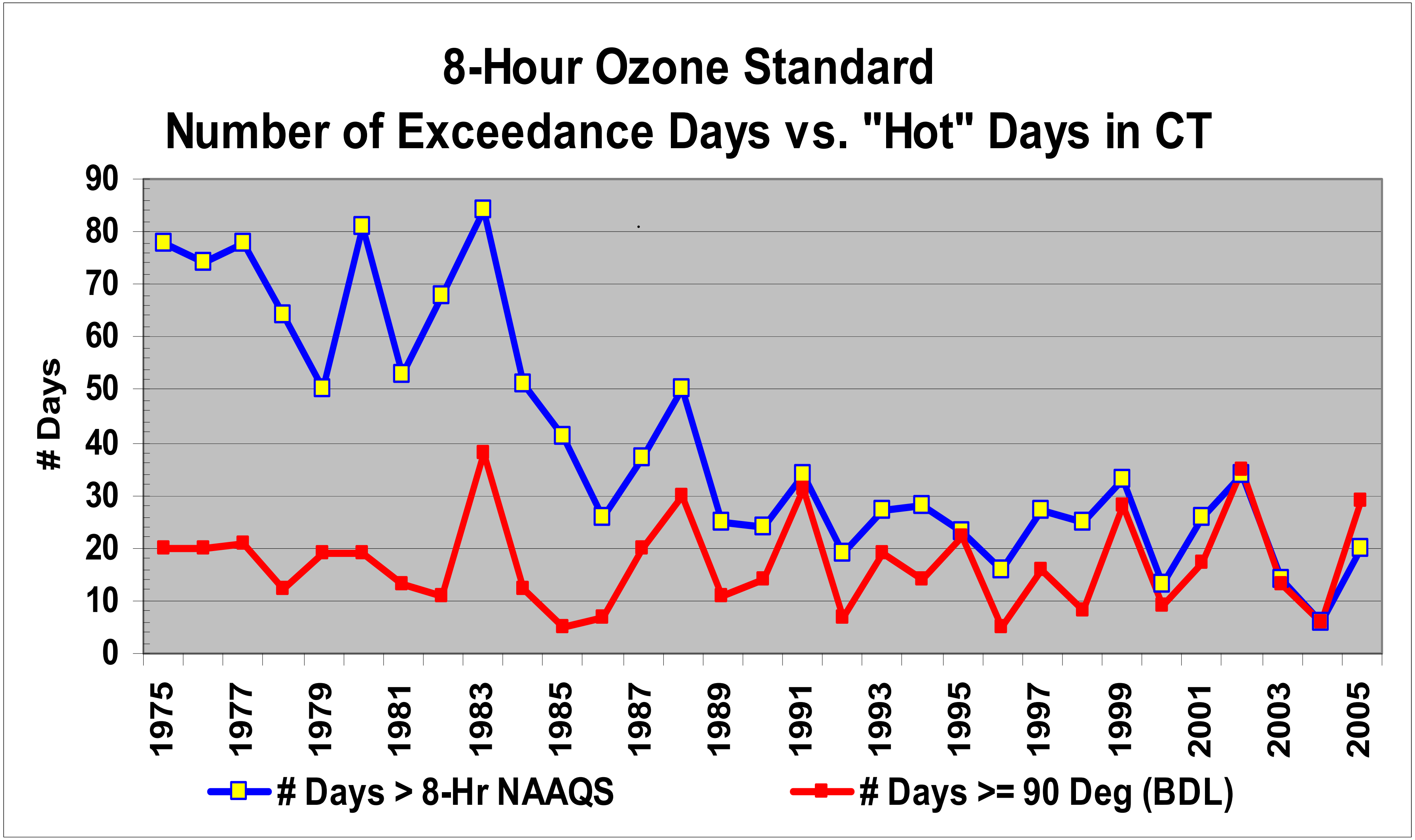
Regional Collaborations

- CT, NY, NJ
  (O3 and PM2.5 SIPs)
- NESCAUM
- MARAMA
- OTC
- MANE-VU
- EPA Regions 1 and 2
- EPA RTP
- RPO’s in MW and SE
- STAPPA
- Other states

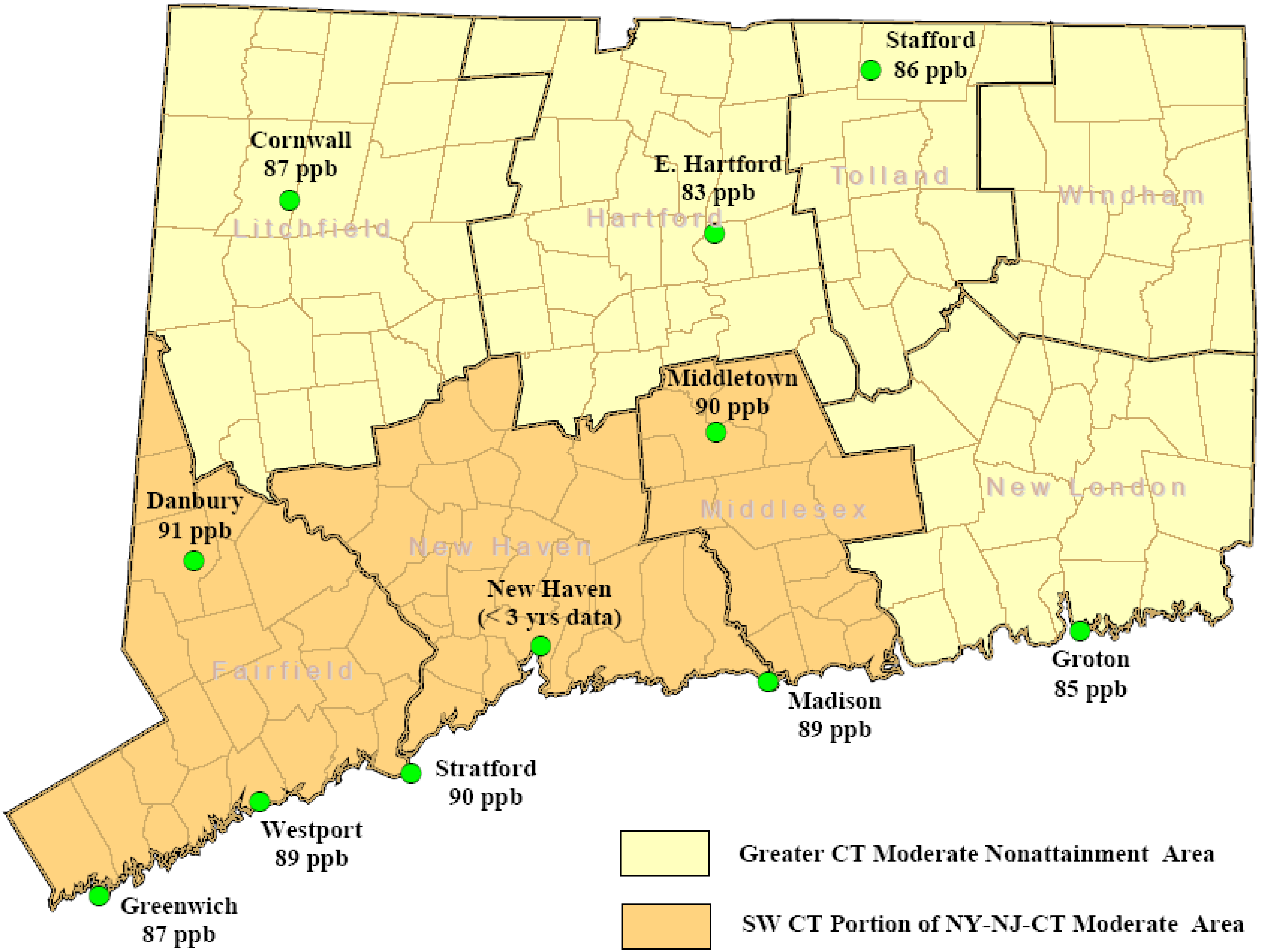
Air Quality in the Northeast
Baseline and Trends



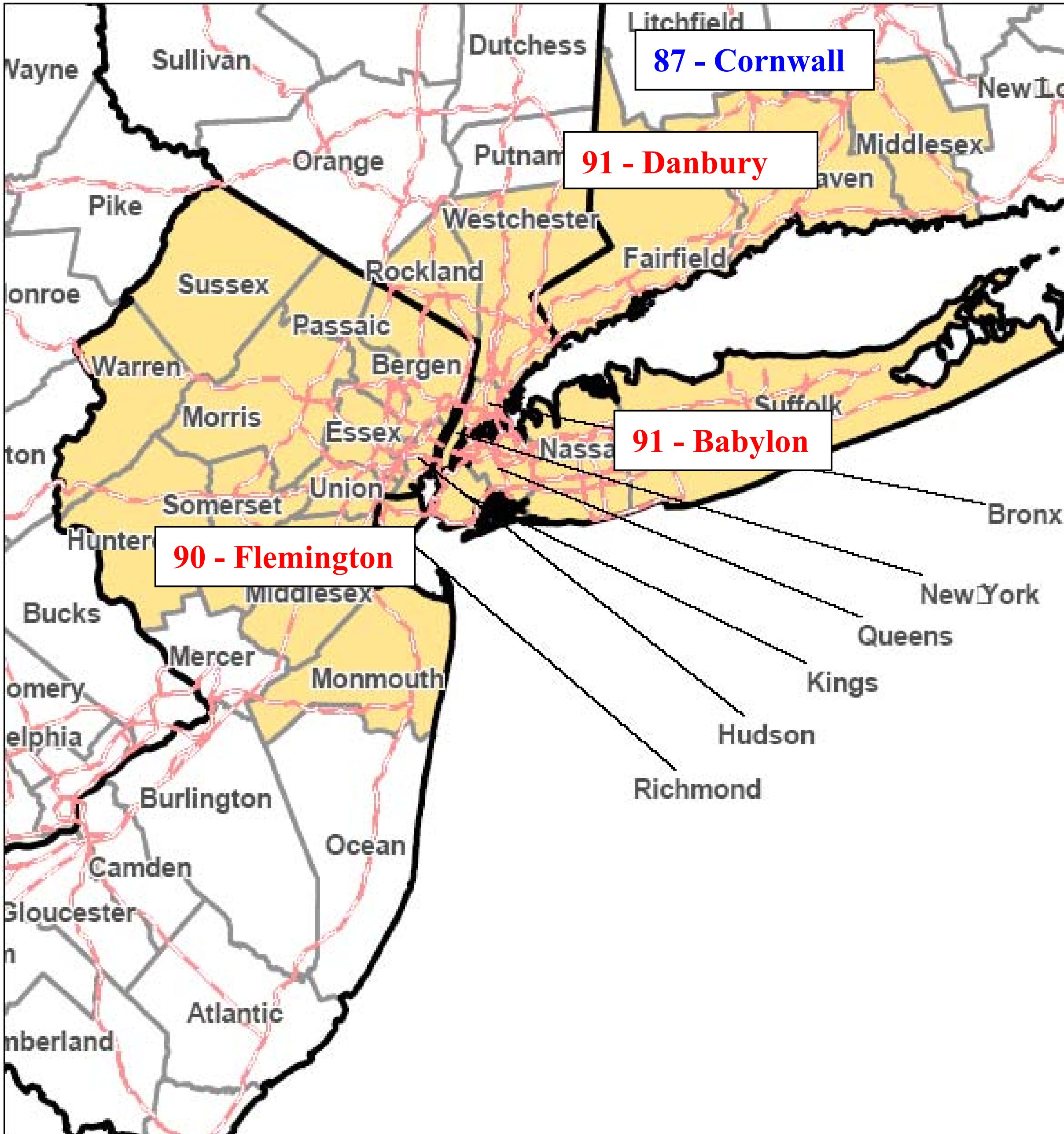
Connecticut 1-Hour Ozone Exceedance Day Trend and Implemented Control Strategies 1975 - 2005
EXCEEDANCE DAYS PER YEAR
YEAR
0
10
20
30
40
50
60
70
1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
▼---Various VOC RACT measures adopted mid-1970's through mid-1990's ---▼
▼ Fed Motor Vehicle Stds MYs 1975+
Portable Fuel Containers 2004+ ▼
Fed Tier I motor vehicles 1994+ ▼
Stage II Gas Enhancements 2005 ▼
Phase I RFG 1995 ▼
NOx RACT 1995 ▼
Non-road Engine Stds 1996+▼
Fed. Consumer Products, AIM & Autobody 1997-98 ▼
CT NLEV 1998 ▼
Enhanced I/M 1998 ▼
OTC NOx Budget 1999 ▼
Phase II RFG 2000 ▼
NOx SIP Call Phase I 2002 ▼
Municipal Waste Combustor NOx 2003 ▼
NOx SIP Call Phase II 2004 ▼
Federal Tier 2 motor vehicles 2004+ ▼
Heavy Duty Diesel Phase 1 2004+ ▼
Stage I Gas. Vapors, 1982-83 ▲
Motor Vehicle I/M 1983 ▲
Gasoline RVP (9.0psi) 1989 ▲
Stage II Gasoline Vapor 1992-1994 ▲


8-Hour Ozone Standard
Number of Exceedance Days vs. "Hot" Days in CT
90
80
70
60
50
40
30
20
10
0
Days
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
Days > 8-Hr NAAQS
Days >= 90 Deg (BDL)

CT 8-hour Ozone Design Values for 2005 (avg of 4th high 2003-2005)



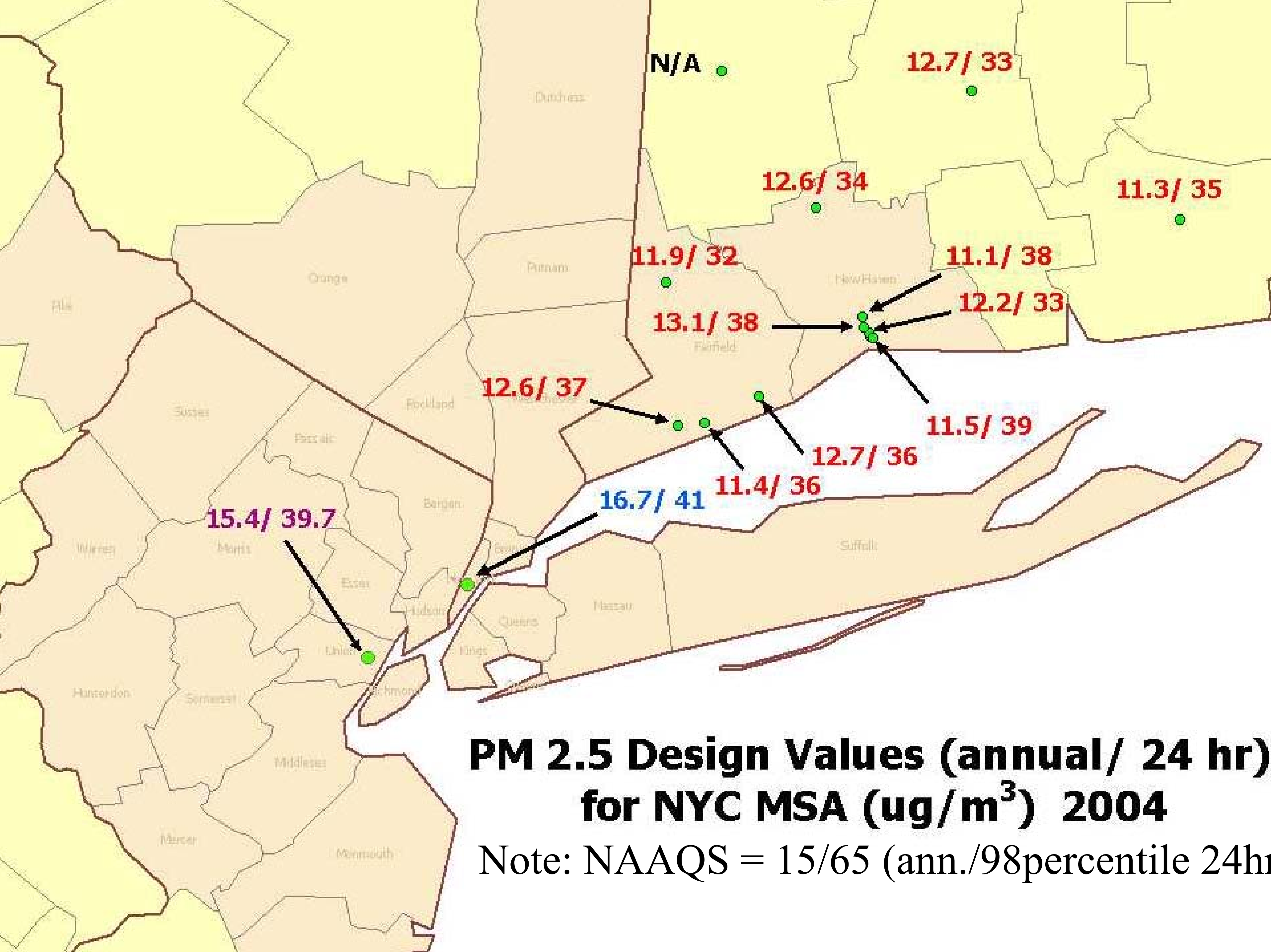
Peak 2005 8-Hour Ozone Design Values for the NYC and Greater CT Nonattainment Areas



Peak 2005 8-Hr Ozone Design Values are in RED for each state in the NYC area (ppb).

The peak 8-Hr Design Value for Greater CT is in BLUE (ppb).

Compliance with the 8-Hr NAAQS occurs when all Design Values do not exceed 85 ppb.


N/A
12.7/ 33
12.6/ 34
11.3/ 35
11.9/ 32
11.1/ 38
12.2/ 33
13.1/ 38
12.6/ 37
11.5/ 39
12.7/ 36
11.4/ 36
16.7/ 41
15.4/ 39.7
Dutchess
Putnam
Orange
Pike
New Haven
Fairfield
Rockland
Sussex
Passaic
Bergen
Warren
Morris
Essex
Hudson
Queens
Kings
Nassau
Suffolk
Hunterdon
Somerset
Middlesex
Mercer
Monmouth
PM 2.5 Design Values (annual/ 24 hr)
for NYC MSA (ug/m3) 2004
Note: NAAQS = 15/65 (ann./98percentile 24hr

Emissions

- **Base Year Inventory 2002**
  - For O3, PM2.5 and RHz SIPs
- **Modeling Inventories Projected to Future Years**
  - 2009 for O3 and PM2.5
  - 2012 for O3
  - 2018 for RHz

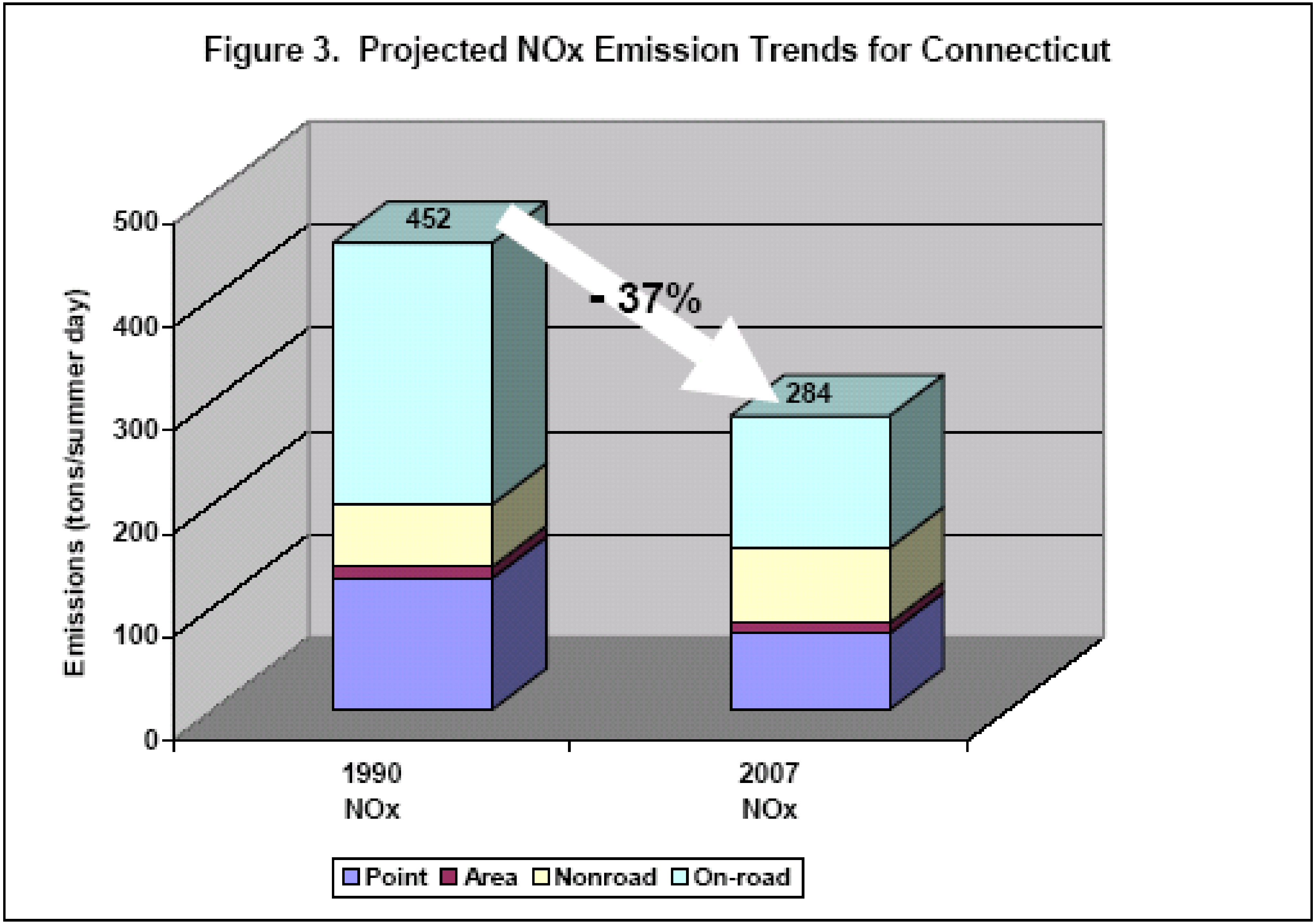
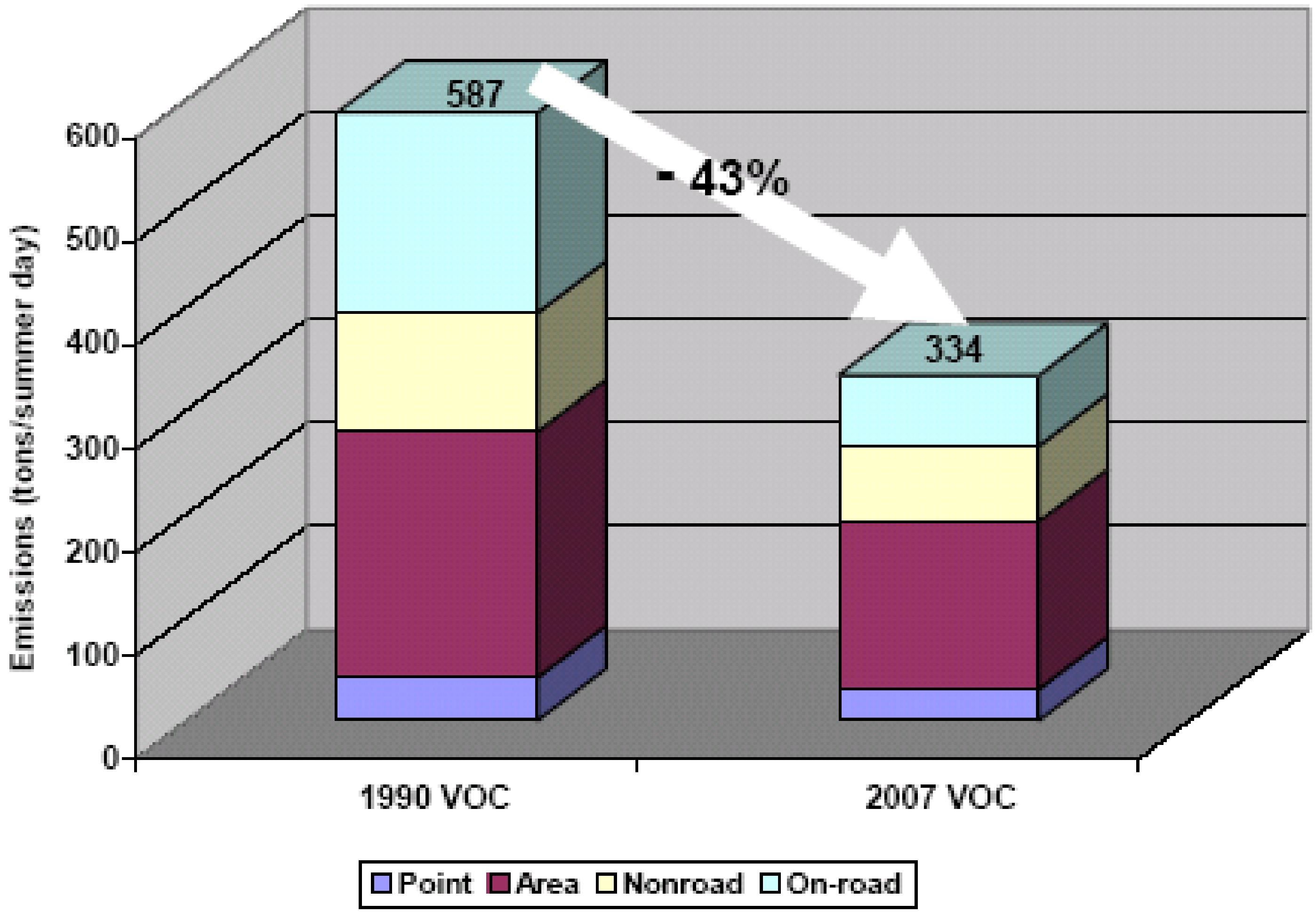
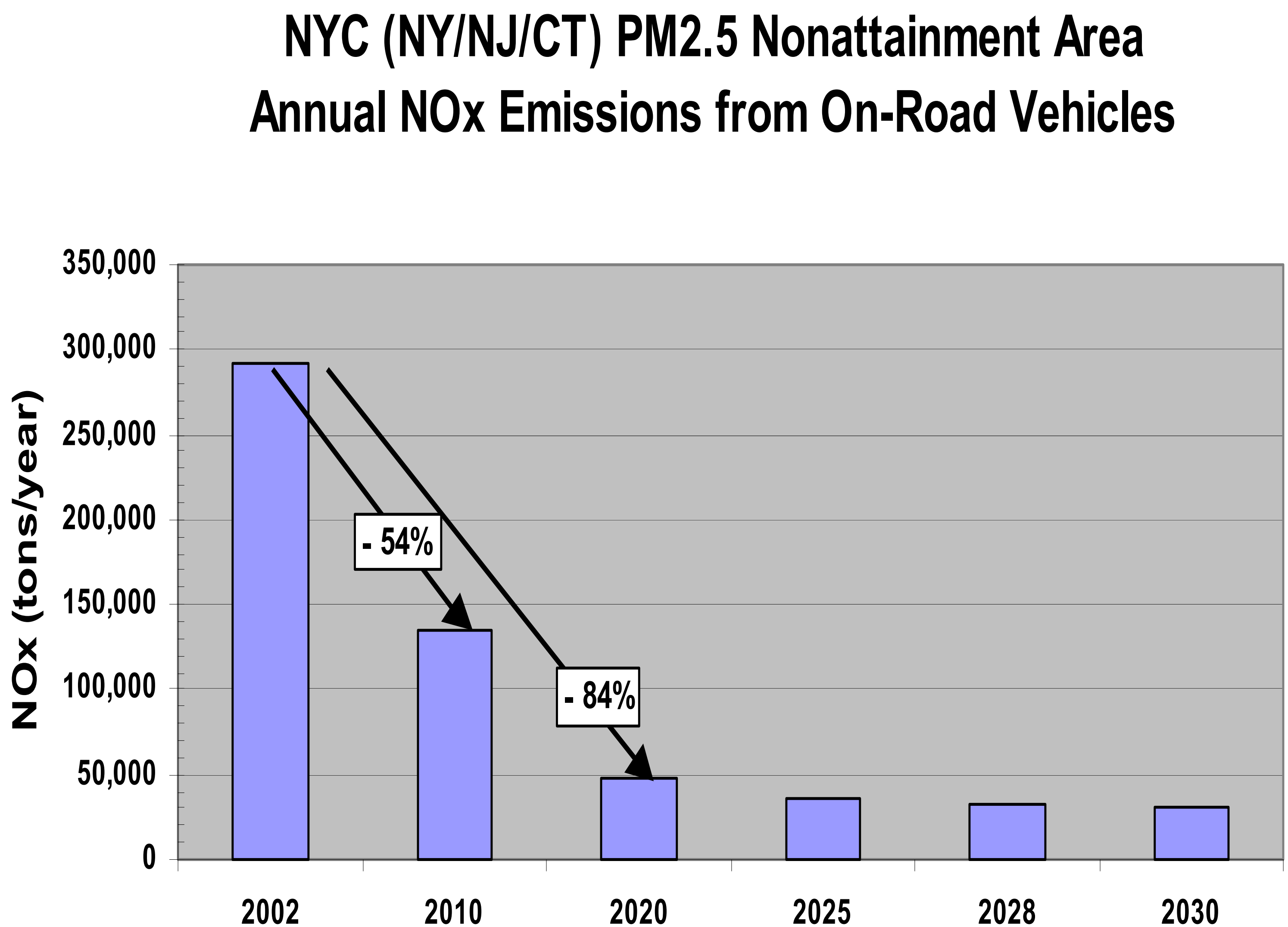


Figure 3. Projected NOx Emission Trends for Connecticut
Emissions (tons/summer day)
0
100
200
300
400
500
452
284
- 37%
1990
NOx
2007
NOx
Point
Area
Nonroad
On-road

Figure 2. Projected Anthropogenic VOC Emission Trends for Connecticut

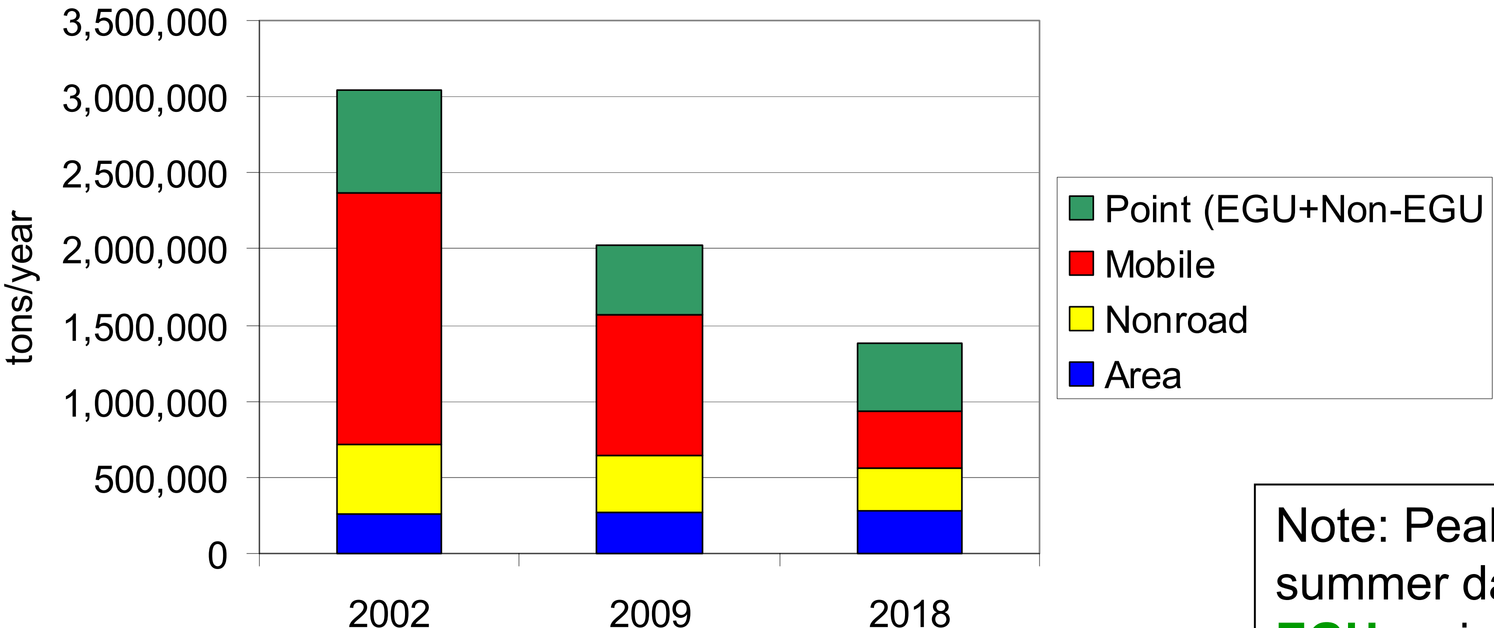




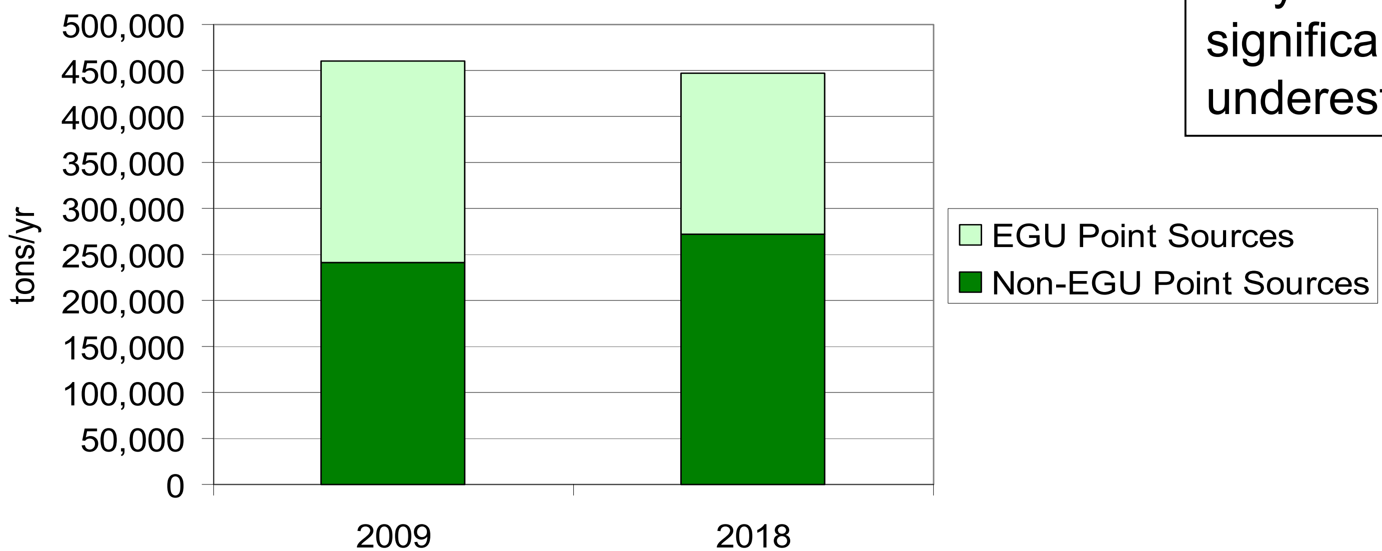
Note: CT's Fairfield & New Haven Counties contribute about 10% of the nonattainment area emissions.

Changes in Modeling Emissions Inventory from 2002 to 2009 and 2018

Annual Total NOx Emissions MANE-VU Region By Category

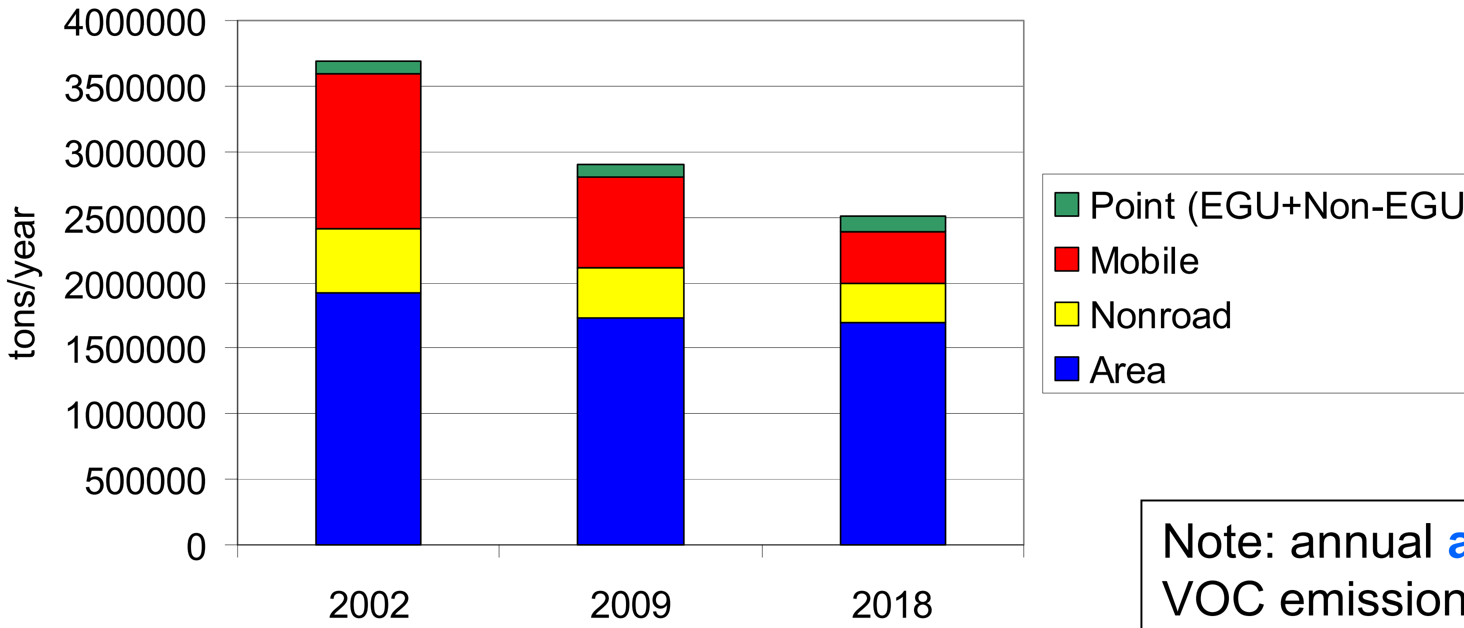


Annual Total Point Source NOx Emissions MANE-VU Region

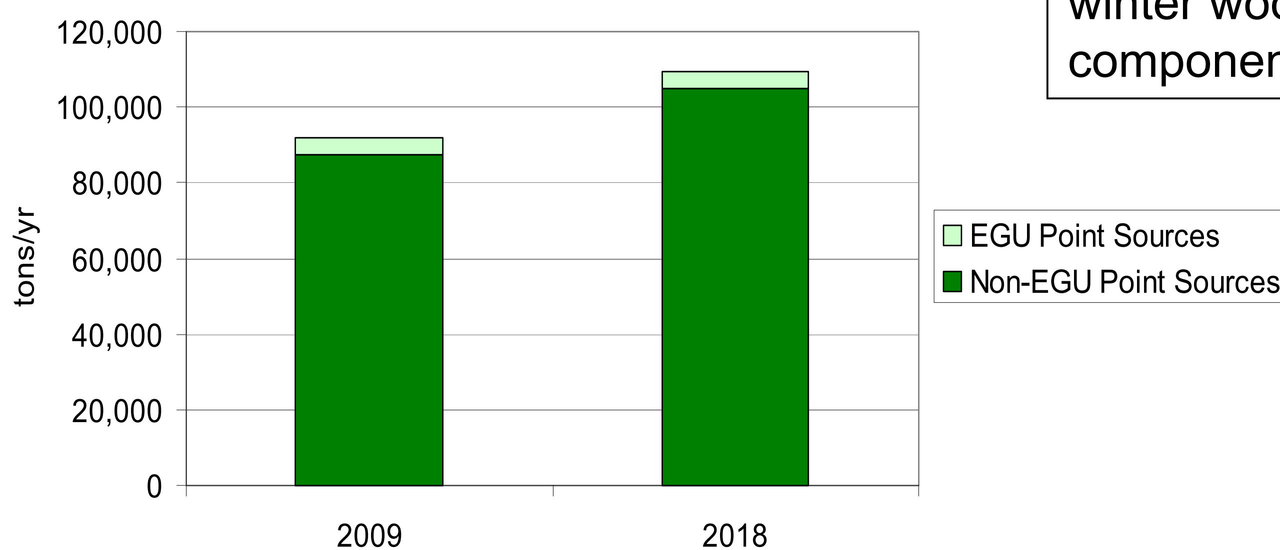


Note: Peak summer day **EGU** emissions may be significantly underestimated

Annual Total VOC Emissions MANE-VU Region By Category



Annual Total Point Source VOC Emissions MANE-VU Region



Note: annual **area** VOC emissions include a significant winter wood burning component

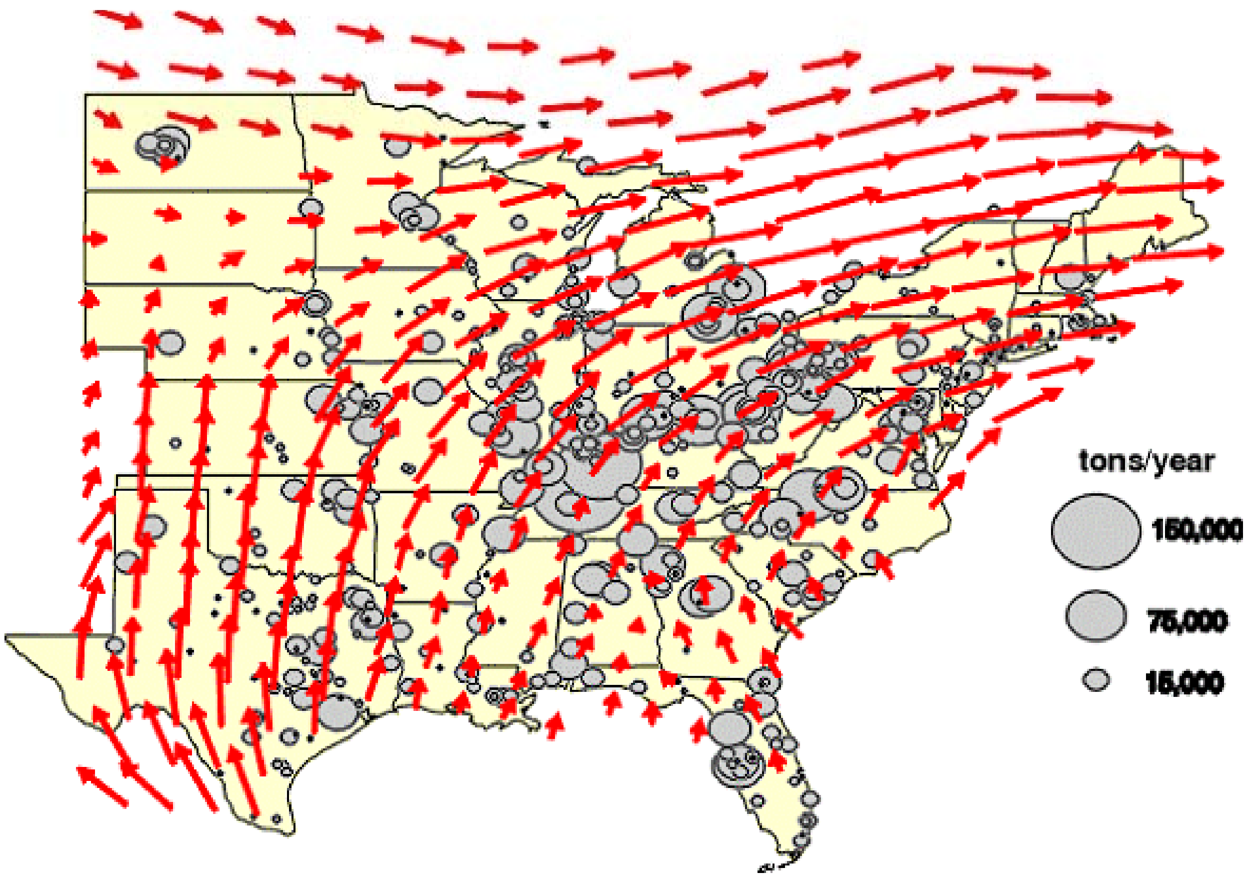
Modeling for Base and Future Years

- CMAQ for O3, PM and RHz SIPs
- CALGRID for O3 strategy development
- REMSAD for RHz
- CALPUFF for BART assessments
- Trajectory Models and Receptor Models for RHz Weight of Evidence Demonstrations

TRANSPORT

CT's air quality is frequently overwhelmed by transport from upwind sources

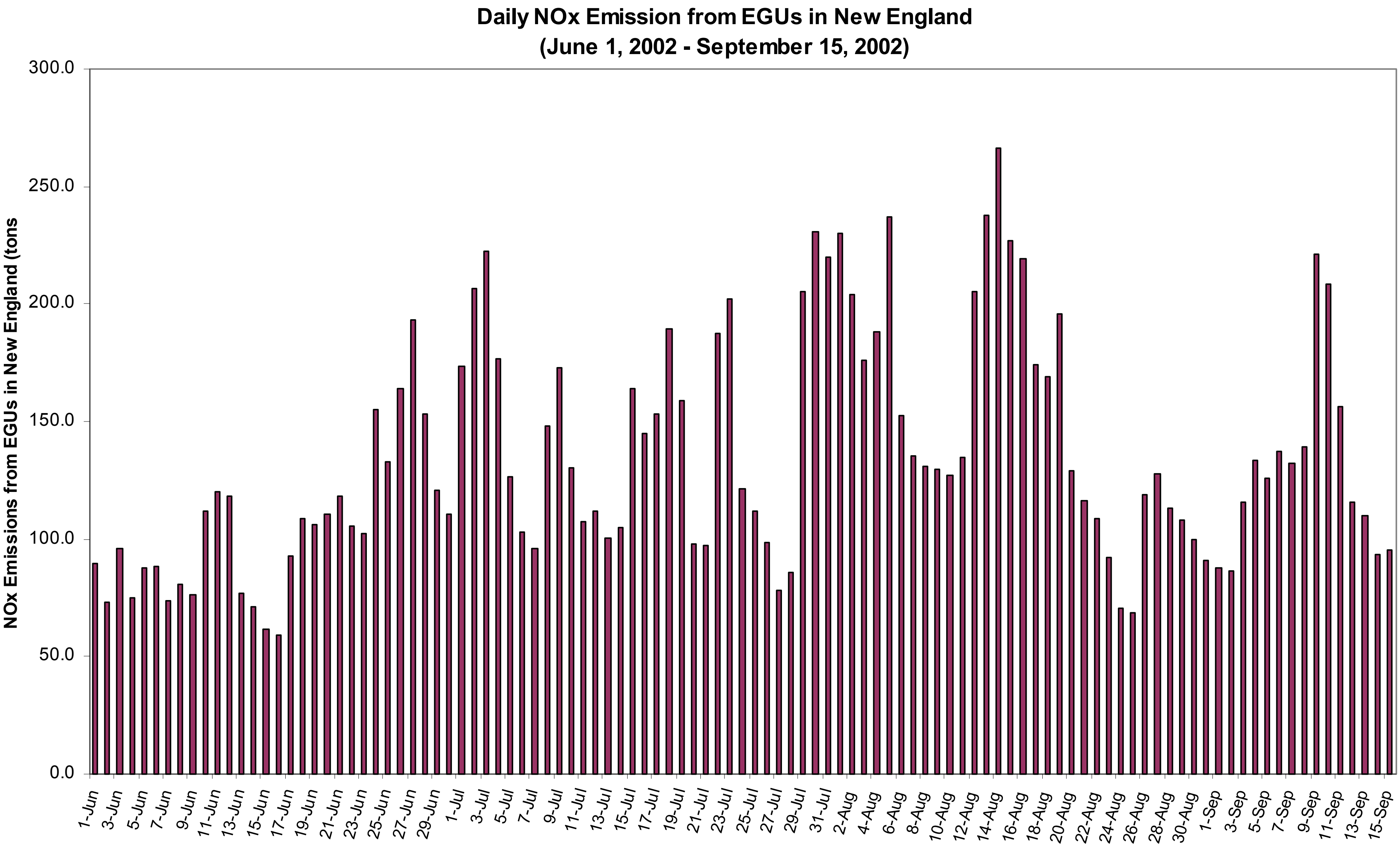
This map overlays NOx sources and wind flow on the 20th percentile high ozone days



NRDC, circa 1996

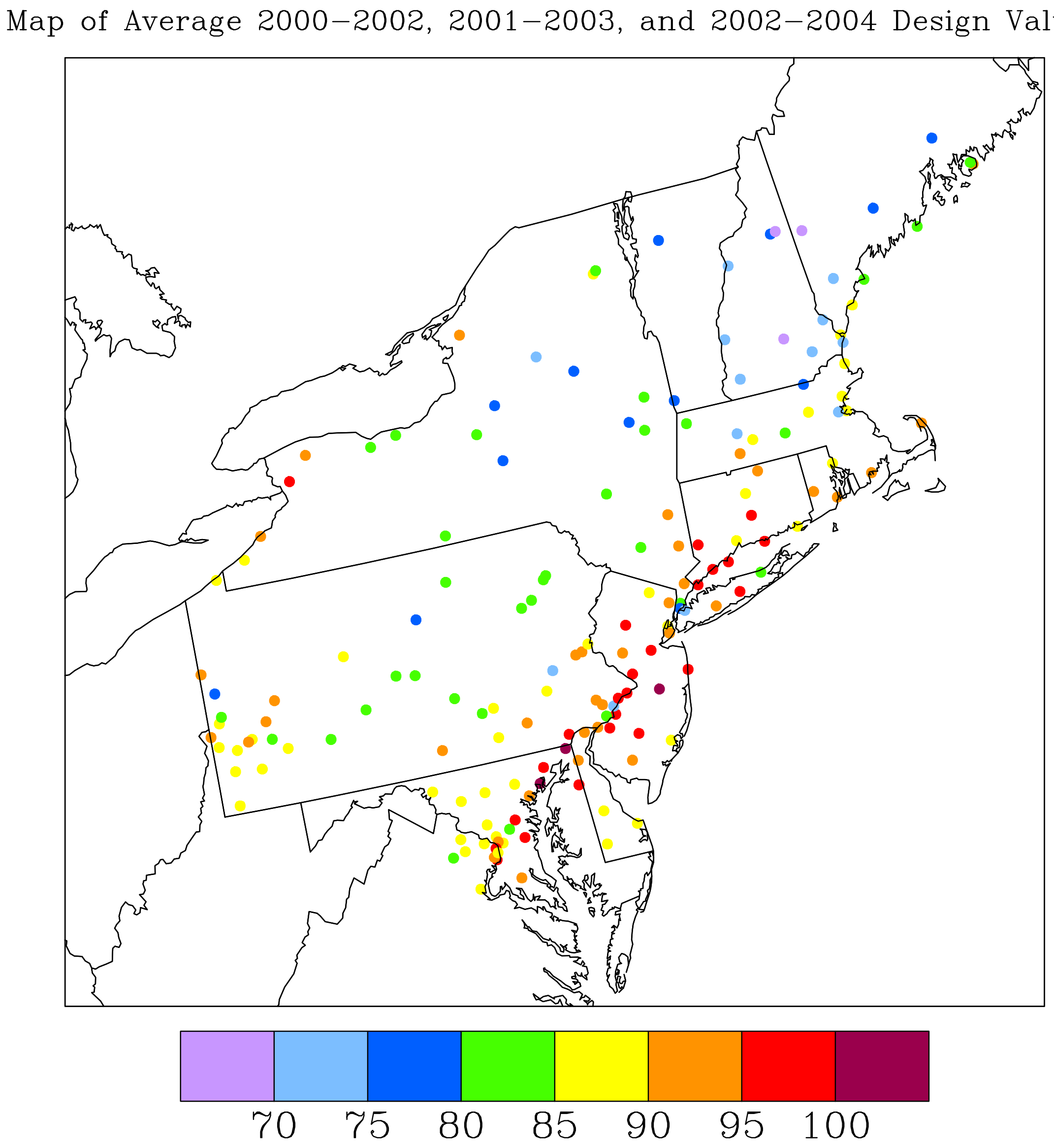
Peak Day Concepts

- High O_3 occurs on hot, sunny days
- NO_x emissions: power plants and fuel combustion
  (air conditioning demand)
- VOC emissions from evaporation and motor vehicles
  (fuels, solvents and vegetation)
- Atmospheric transport from W and S
  (in NY,NJ,CT, hot days = SW winds from urban corridor + Ohio Valley power plants)



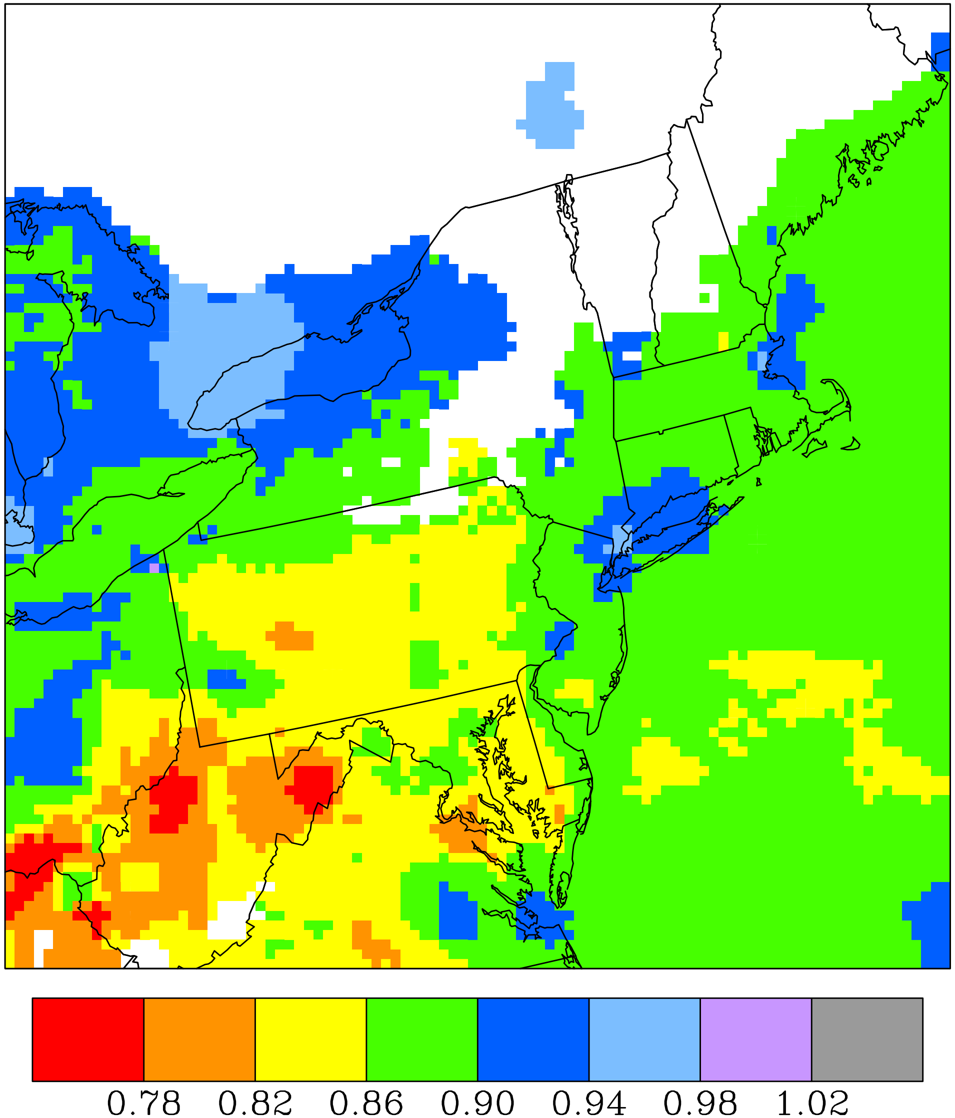
Note: Baseload and peaking units are shown. Although peakers only operate a limited number of hours per year, they contribute signficantly to NOx emissions on hot days.

"Current Design Values (DVC)" Determined from Observations

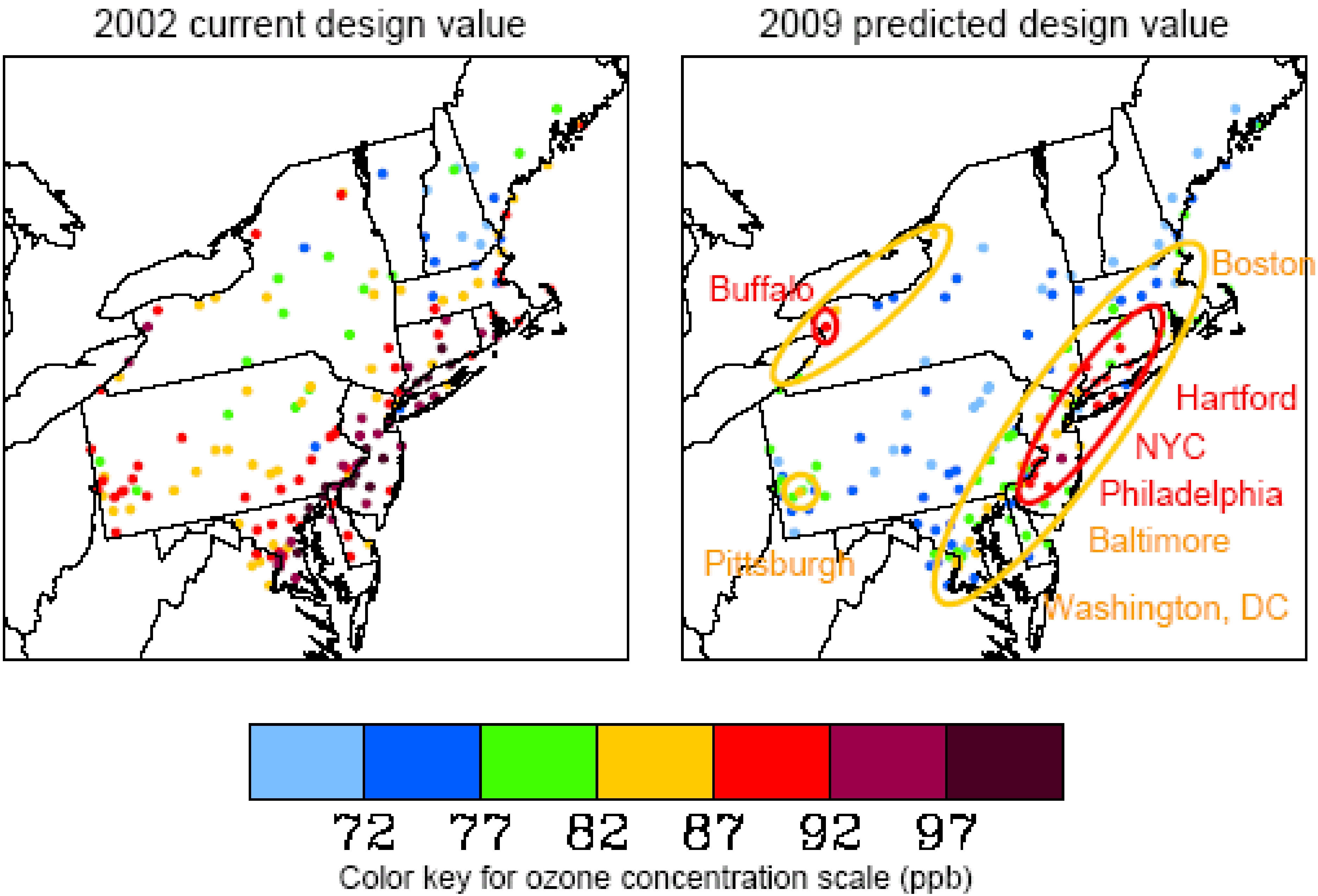


Average of 8-hr O_3 Design Values for 2000-2002, 2001-2003, and 2002-2004 at OTC monitors ("Current Design Values" for the purpose of the modeled attainment test)

Relative Reduction Factors (RRF) Calculated From CMAQ Simulations with 2002 and 2009 Base Case Emissions For May 15 – September 29



- Relative Reduction Factors (RRF) were calculated from the corrected 2002 and 2009 base case scenarios
- The 2009 base case includes CAIR and other "OTB/OTW" measures
- RRF calculation was performed for each grid cell, considering values in surrounding grid cells (3*3 array) and only days that fulfill the threshold criteria as specified in the guidance on pages 15-17, 21-24, and 60-64
- For uncolored regions, fewer than 5 days ≥ 70 ppb were predicted in the 2002 base case, therefore no RRF could be calculated per guidance


2002 current design value
2009 predicted design value
Buffalo
Boston
Hartford
NYC
Philadelphia
Baltimore
Pittsburgh
Washington, DC
72
77
82
87
92
97
Color key for ozone concentration scale (ppb)

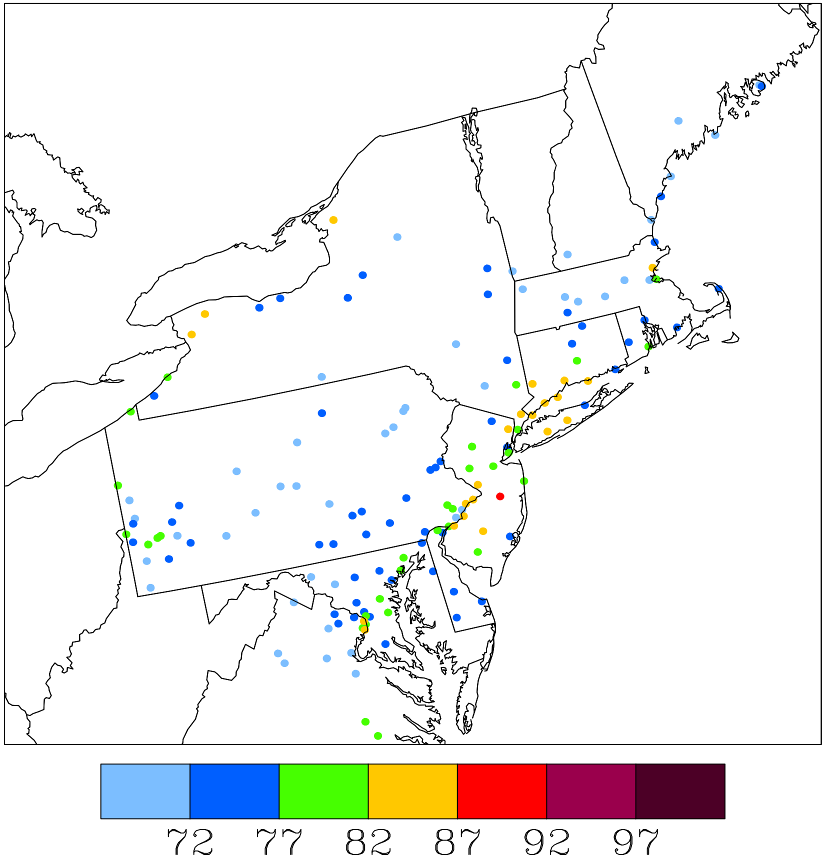
CMAQ Modeling Caveats

- The emission inventories for MANE-VU, VISTAS and MRPO (both 2002 and 2009), will be updated

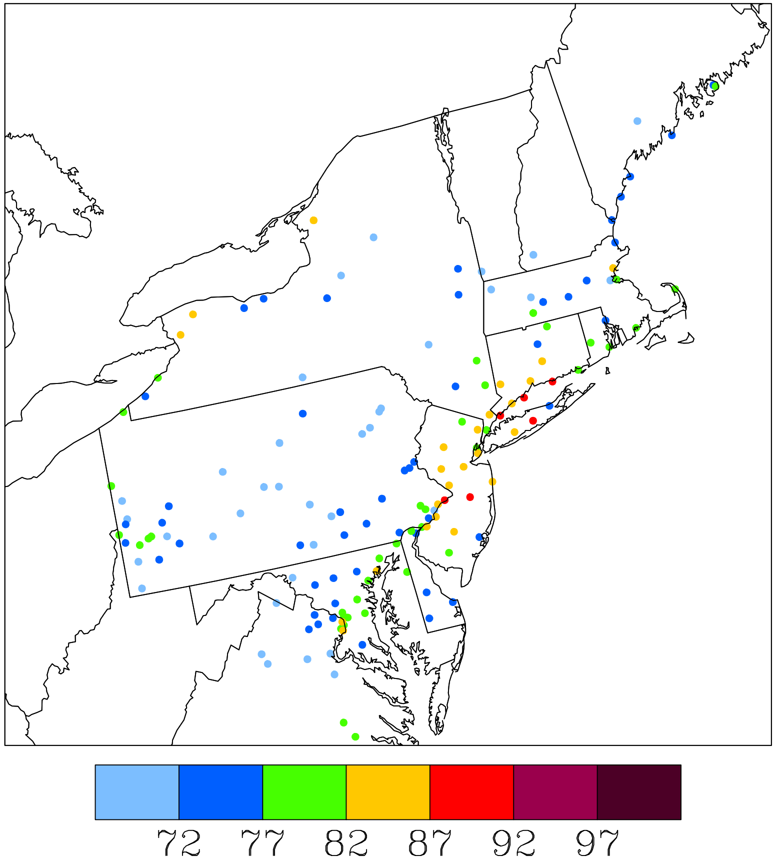
Sensitivity tests of DVF to Emission Reductions Relative to the 2009 OTB/OTW Base Case

Category	Case 5 (not too "reasonable")	Case7 ("reasonable")
Area Sources	30% VOC/CO/NOx reductions within the inner OTR corridor	10% VOC/CO reductions across the entire MANE-VU region
Nonroad Sources	30% VOC/CO/NOx reductions within the inner OTR corridor	No reductions
Mobile Sources	No reductions	No reductions
Non-EGU Point Sources	30% VOC/CO/NOx reductions within the inner OTR corridor	30% NO_x reductions across the entire MANE-VU region
EGU Point Sources	30% VOC/CO/NOx reductions domain-wide	30% VOC/CO/NOx reductions domain-wide

DVF 2009 Case5



DVF 2009 Case7



Findings for 2009 Base Case CMAQ and CALGRID Modeling

- Continued 8-hr ozone nonattainment in 2009, but improvement with emission reductions

- Suggests the need for aggressive emissions reductions and possibly more time beyond 2009

One Path to Attainment

- EGU NOx Reductions
  - OTC/Midwest collaborative (CAIR+ summer!)
  - Reduce peak day EGU NOx (inner corridor)
- Mandatory Bump-up
  - From moderate (2009 attain) to serious classification (2012 attain)
  - CT, NY, NJ (PA, MD, DC, VA?)
- Backstops
  - Same states petition EPA under Section 126
  - States sue EPA under Section 110(a)(2)(D)

Stationary Source Control Strategies for CT

BOTW (Beyond On the Way) Control Strategies for CT include:

- Solvent Cleaning
- Consumer Products
- AIM Coatings
- ICI Boilers (Non EGUs)
- Tighter CAIR budget (EGUs)
- Peak day EGU strategies

Draft OTC Control Strategies

The following O3 measures being discussed by the OTC may need to be addressed in CT:

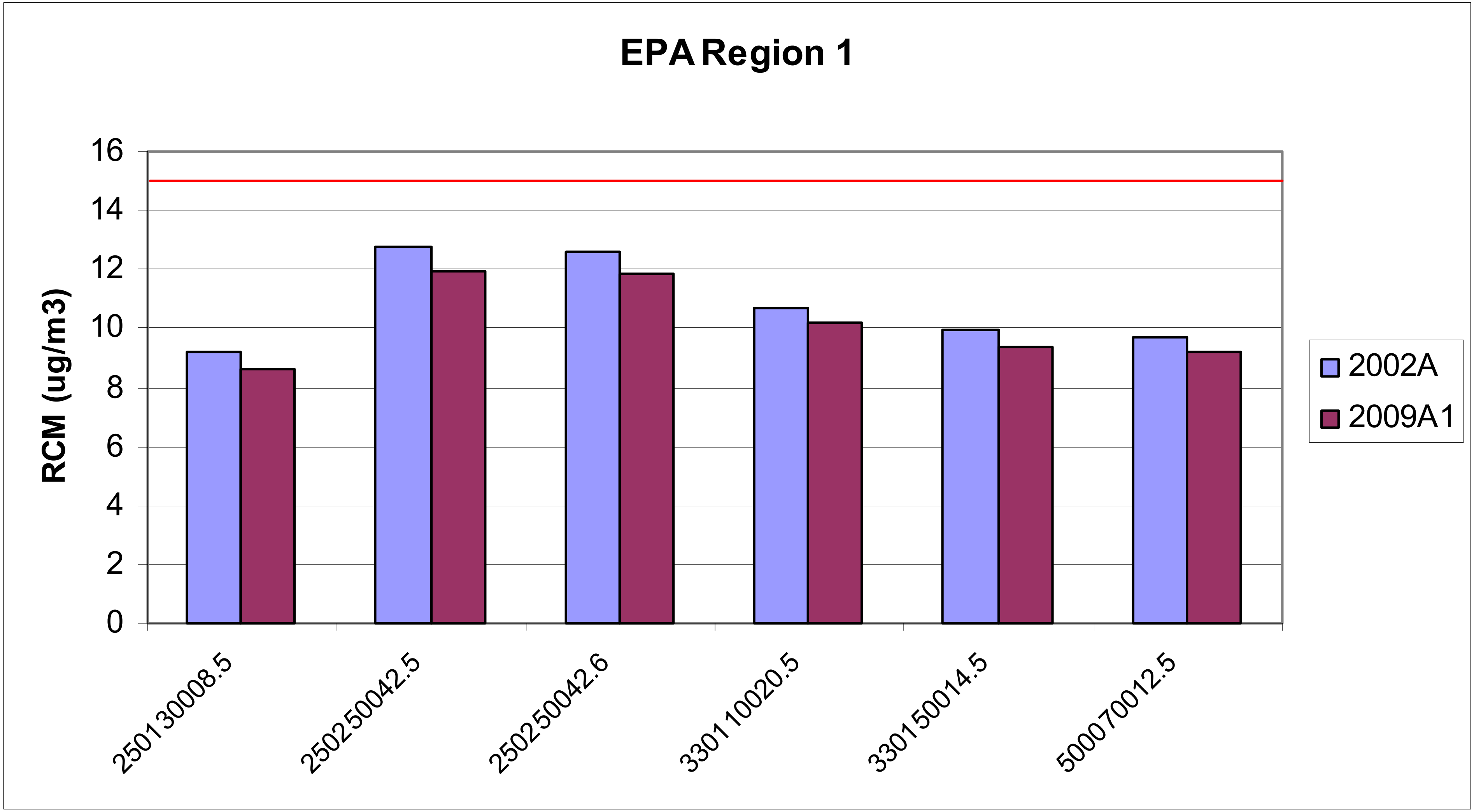
- Consumer Products
- Portable fuel containers
- Industrial adhesives and sealants
- Asphalt paving
- Asphalt production plants
- ICI boilers
- Chip reflash
- Regional fuels

Predictions for $PM_{2.5}$

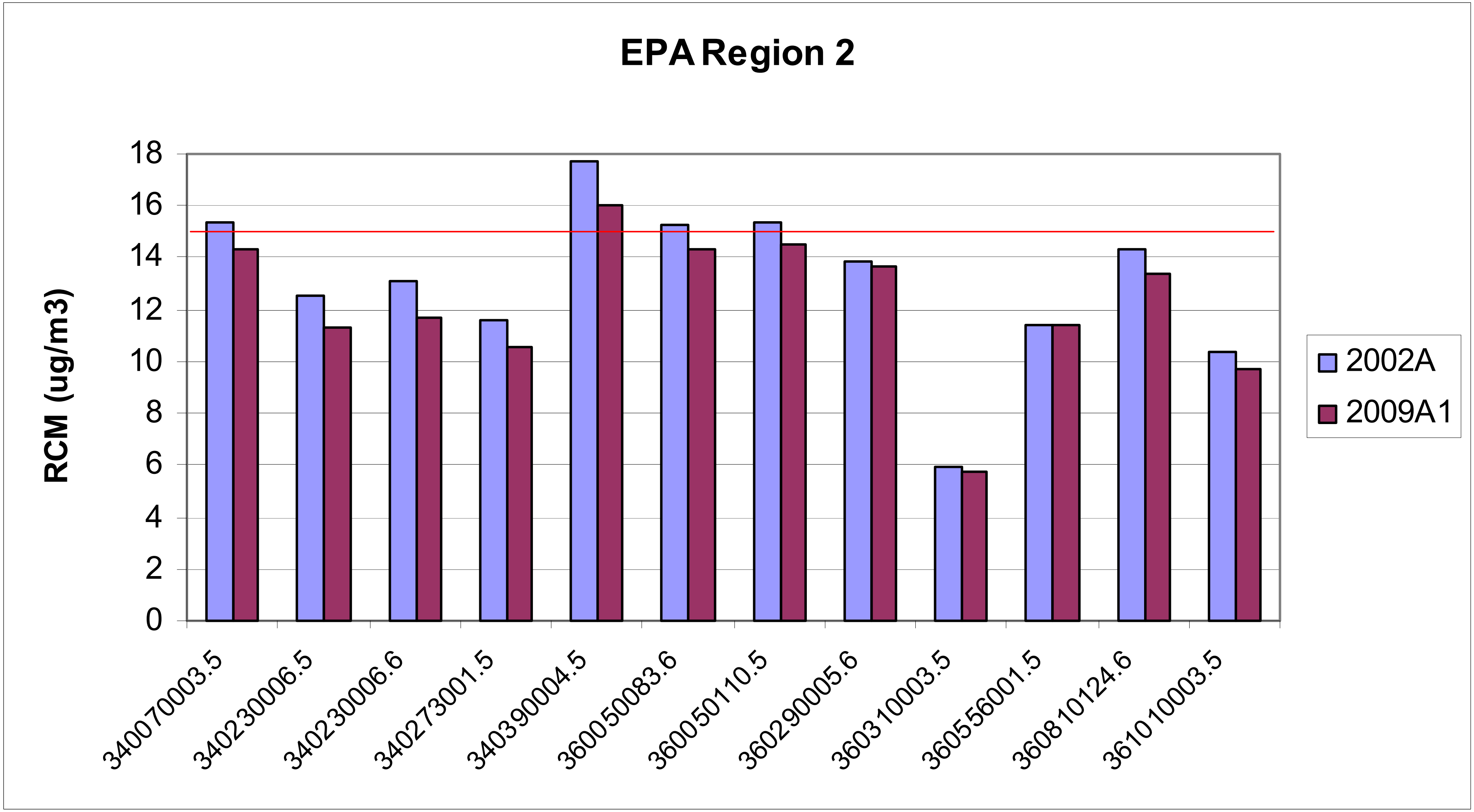
- Utilized 2002 & 2009 CMAQ simulations
- 31 STN Monitors across the OTR
- Compute reconstructed mass (RCM) from STN measurements
- Based on quarterly average measurements
  - 2002 RCM = $1.37 \times SO_4 + 1.29 \times NO_3 + EC + OM + Crustal$
  - 2009 RCM = $RRF_{SO4} \times [1.37 \times SO_4] + RRF_{NO3} \times [1.29 \times NO_3] + RRF_{EC} \times [EC] + RRF_{OM} \times [OM] + RRF_{Crustal} \times [Crustal]$

Where $RRF_x = CMAQ_{x,2009} / CMAQ_{x,2002}$

- Guidance and software programs still due from EPA



EPA Region 1
RCM (ug/m3)
0
2
4
6
8
10
12
14
16
250130008.5
250250042.5
250250042.6
330110020.5
330150014.5
500070012.5
2002A
2009A1


EPA Region 2
RCM (ug/m3)
0
2
4
6
8
10
12
14
16
18
340070003.5
340230006.5
340230006.6
340273001.5
340390004.5
360050083.6
360050110.5
360290005.6
360310003.5
360556001.5
360810124.6
361010003.5
2002A
2009A1

Regional Haze Modeling

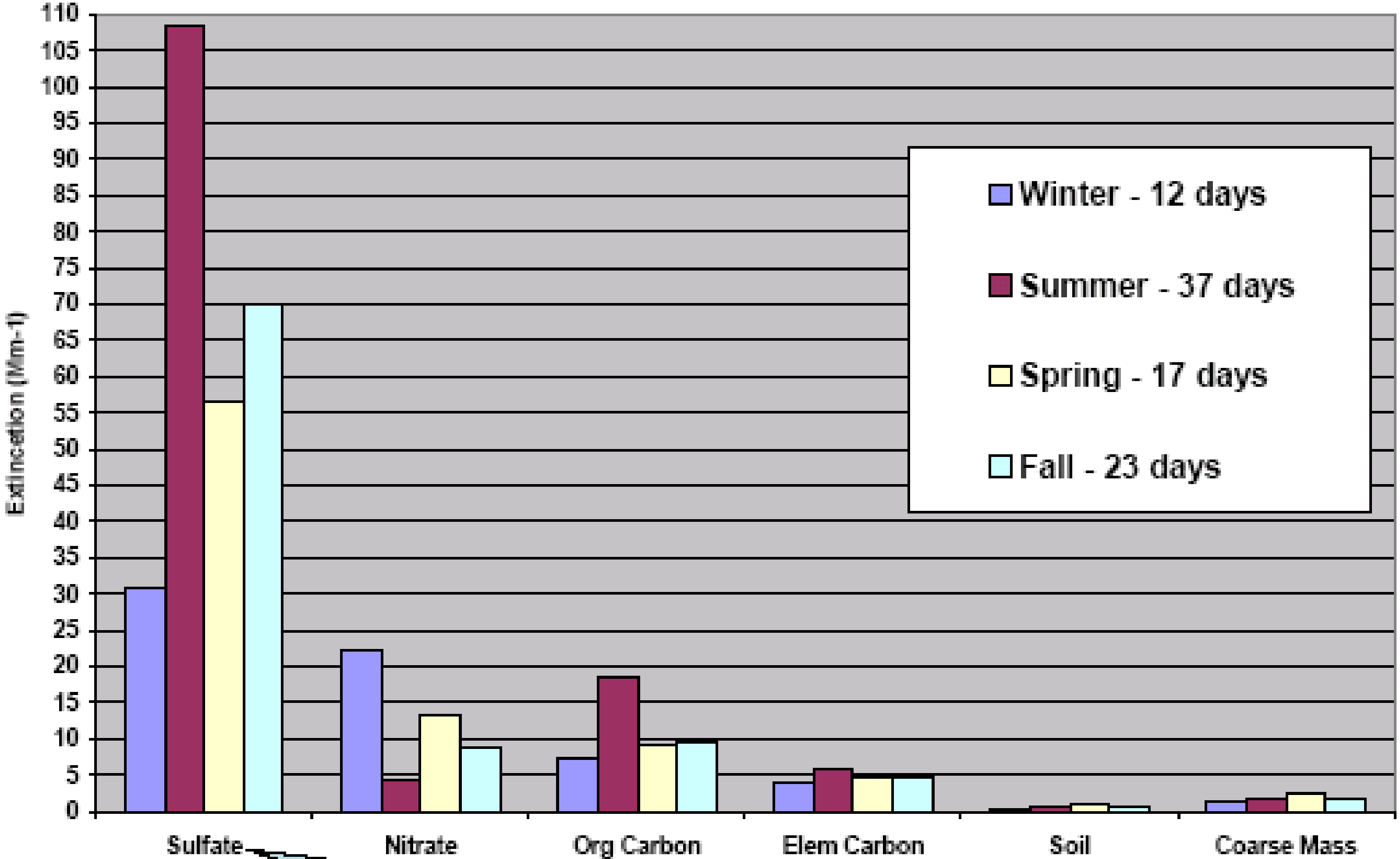
NESCAUM

www.nescaum.org


Regional Planning Organizations
Western Regional Air Partnership
Central Regional Air Planning Association
Midwest Regional Planning Organization
Mid-Atlantic/Northeast Visibility Union
Visibility Improvement State and Tribal Association of the Southeast

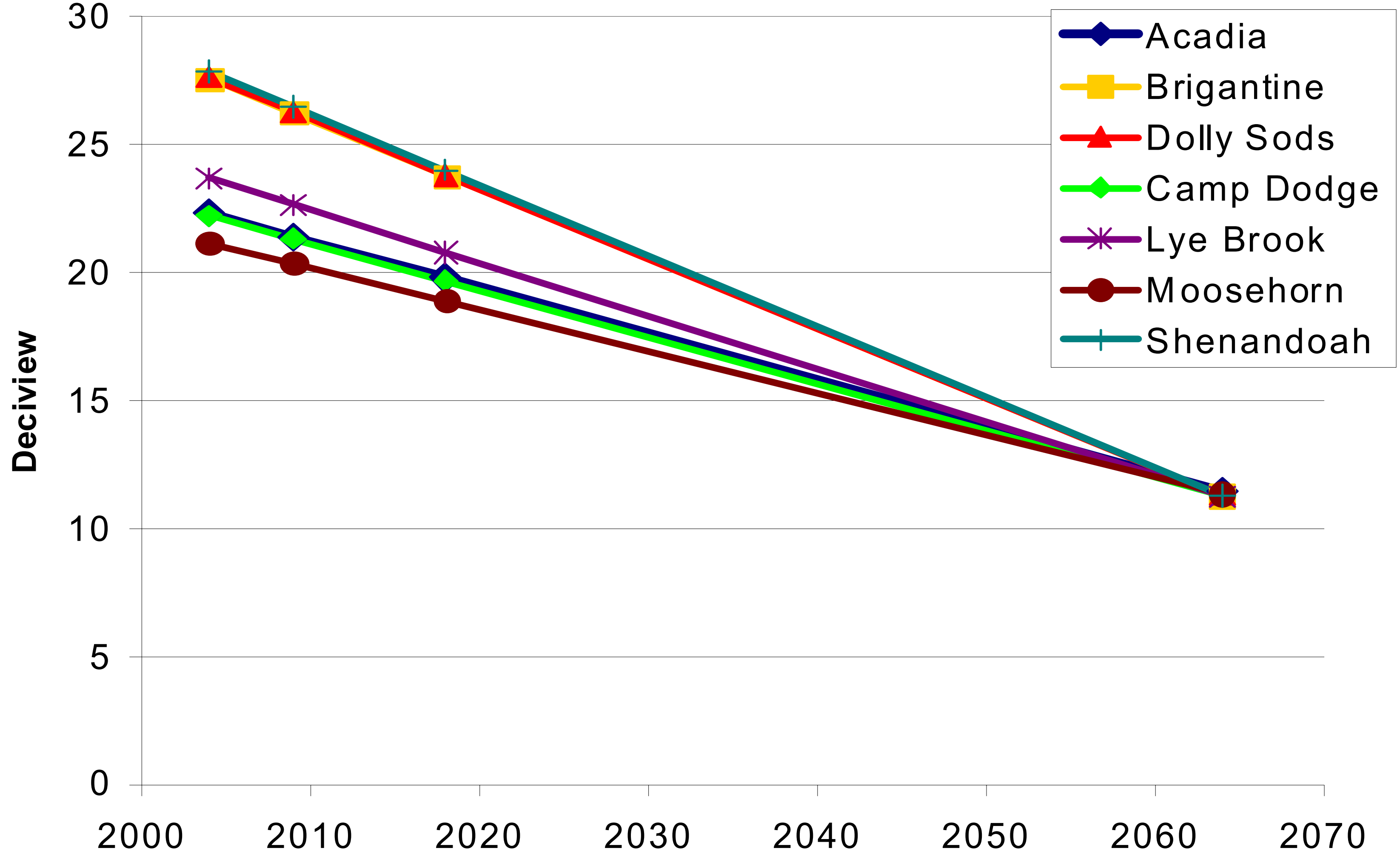
Seasonal Analysis of the 20% Worst
2000-2003 Visibility Days at Lye Brook, VT

Courtesy of Tom Downs, Maine DEP



VTAPCD Comment: Except for winter nitrate, on worst visibility days, **SO_4** is at least 5 times and generally 10 times as responsible for light extinction as other components.

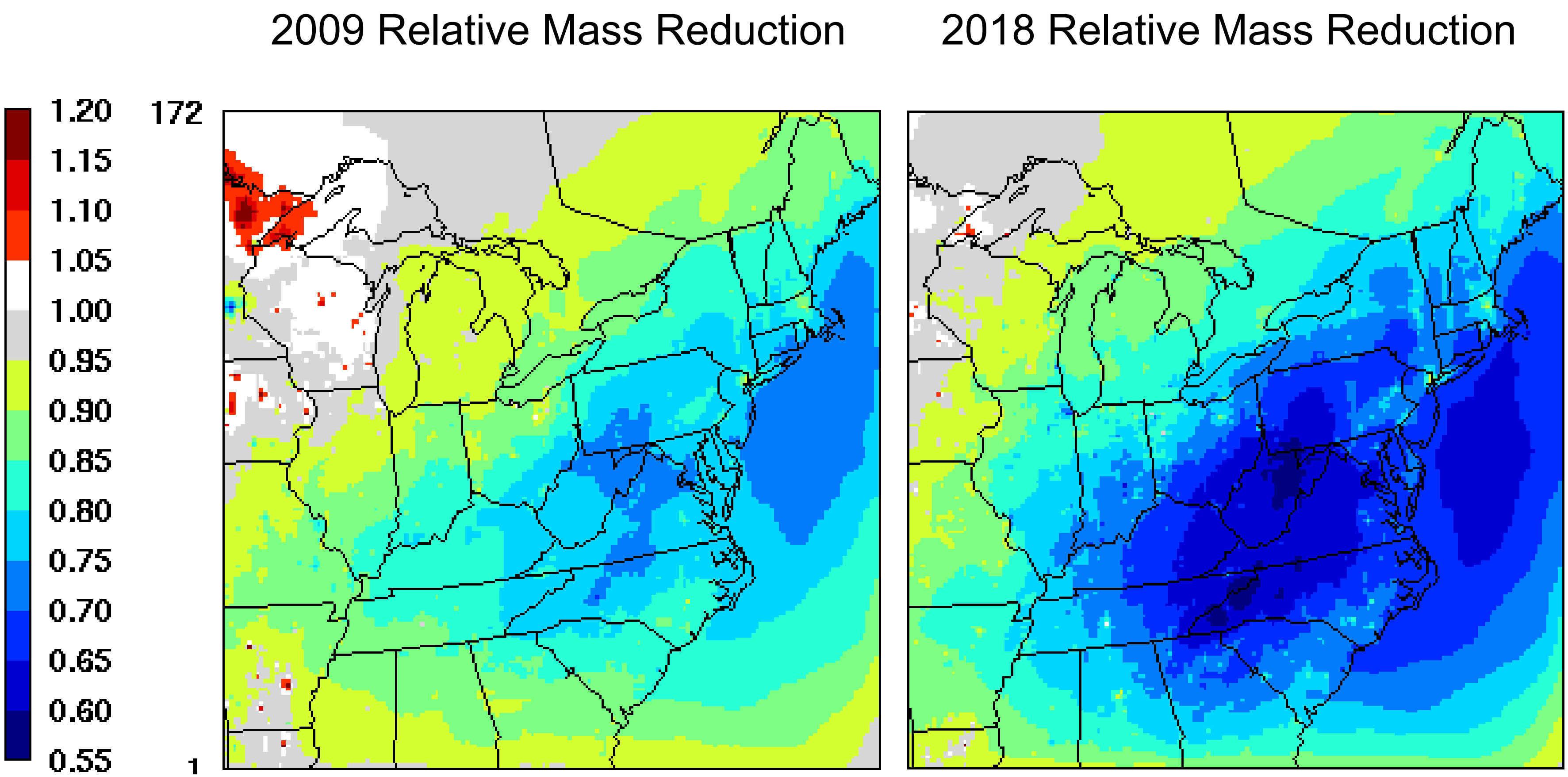
Baseline visibility and implied 2009 and 2018 uniform progress goals



2002/2009/2018 Base Results

- 20% best/worst RRFs calculated across the year
- Preliminary calculations use a combination of Base A and Base A1 when available (May-September)
- Species specific RRFs applied to baseline conditions at each IMPROVE site

Average Sulfate Reductions

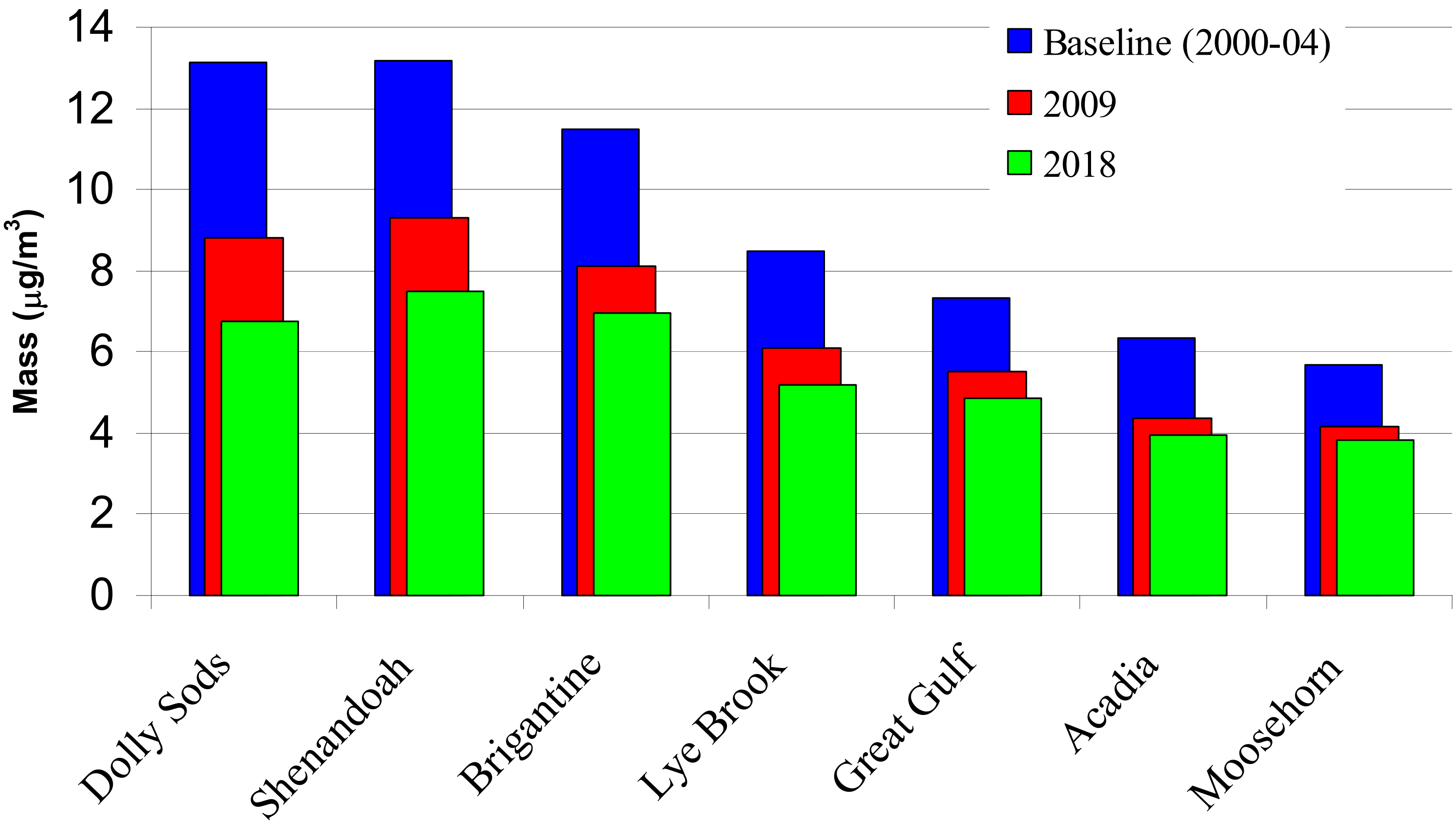


Class I Site RRFs

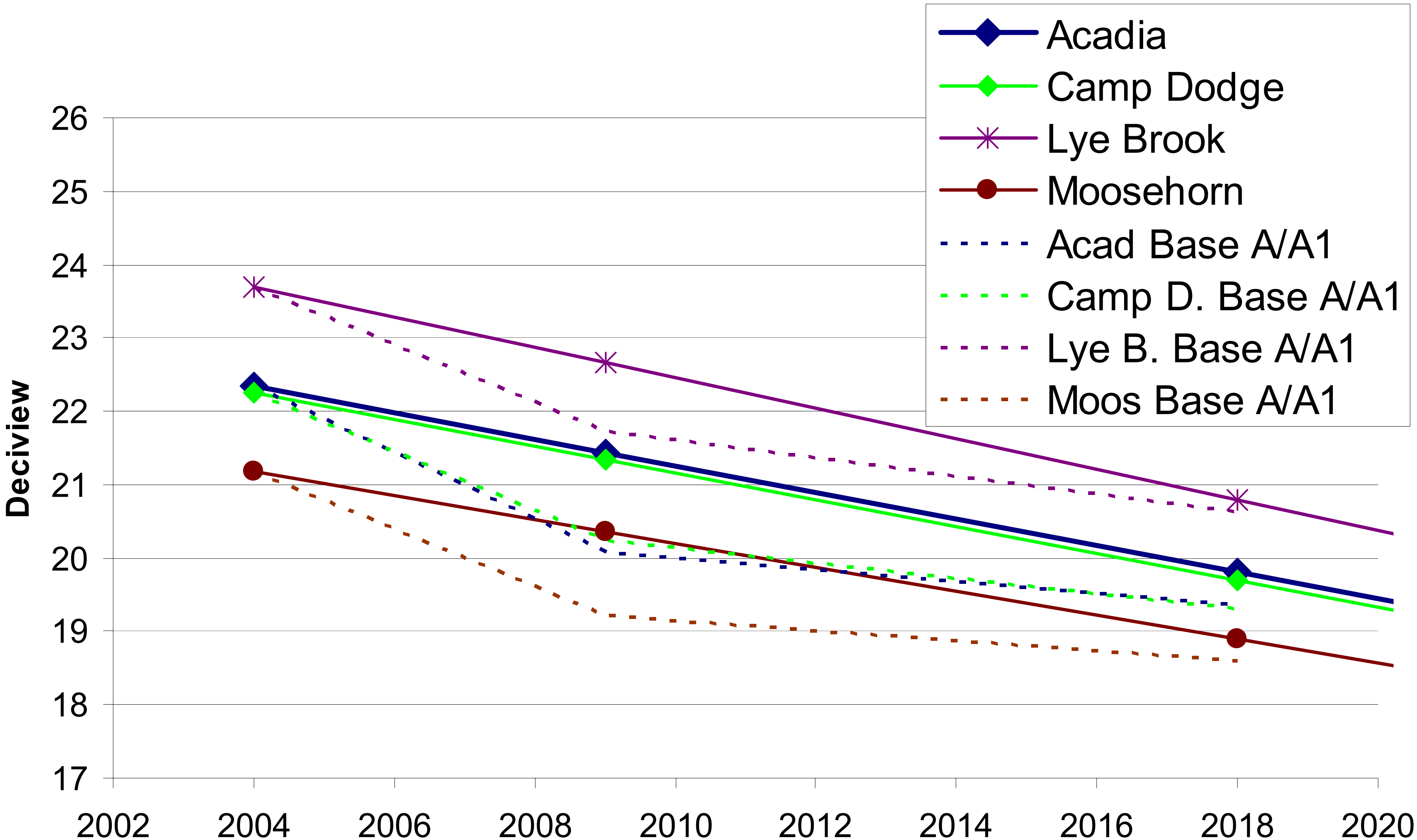
- Site-specific modeled PM mass
- Ranked as DV using default IMPROVE extinction equation (monthly f(RH))
- 20% worst days were compared for 2002, 2009 and 2018, species by species
- These ratios are applied to “actual” IMPROVE monitoring data

Projected Mass Reductions

20% Worst Modeled Ammonium Sulfate Values



Relative mass reductions applied to visibility metric for New England sites



Relative mass reductions applied to visibility metric for Mid-Atlantic sites